VLBA PROPOSAL COVERSHEET

rcvd:

DEADLINES: 1st of Feb., June, Oct.

(1) Date Prepared: May 31, 2006

(2) Title of Proposal: Follow-up of the VLBA Calibrator Survey

(3) AUTHORS (Add * for new location)	INSTITUTION	E-mail	Students Only G/U	For Thesis?	Ph.D. Year
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(4) Related previous or current VLBI proposal(s): BB023, BF071, BP110, BP118, BK125 ◯ Resubmission

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(7) Scientific Category: ⊗ astrometry & geodesy ◯ galactic ◯ extragalactic ◯ other:
Rapid Response Science: ◯ Known Transient ◯ Exploratory ◯ Target of Opportunity

(8) Wavelength(s) requested (those not available on the global network are indicated with a small circle):
◯ 90cm ◯ 50cm ◯ 30cm ◯ 21cm ◯ 18cm ◯ 13cm ◯ 6cm ◯ 5cm ◯ 3.6cm ⊗ 3.6/13cm
◯ 2cm ◯ 1.3cm ◯ 7mm ◯ 3mm
◯ Global Network standard bands ◯ Special frequencies: _____

(9) Recording format: ⊗ Default continuum setup (VLBA only), ◯ VLBA/MkIV, ◯ MkIII: Mode _____
Bandwidth per BaseBand channel: _____
Aggregate bit rate: 128 (8 BB channels at 16 MSamples/sec of ⊗ 1 bit, ◯ 2 bit)

(10) ◯ Multi-epoch observation: _____ epochs of _____ hours each, separated by _____

(11) Network	Requested antennas	Total time requested
EVN & MERLIN		
VLBA	ALL	2×24 hours
other NRAO		
Non-VLBI Instruments		

(12) ABSTRACT (Do not write outside this space. Please type)

The VLBA Calibrator survey is the most complete listing of more than 3000 compact sources, their coordinates, visibility plots and images. These data were collected from 22 VLBA sessions, each of 24 hours, between 1994 and 2005. This catalogue is crucial for successful VLBA phase referencing and for selection of sources needed for geodetic programs.

We request two additional 24 hour follow-up sessions with the VLBA to re-observe about 50 sources in order to improve significantly their coordinates and images and to observe 250 new candidate sources which will be added to the list of calibrators. The purpose of this project is to improve the VLBA Calibrator list for benefits of the community.

Scheduler use only
(8/03)

(13) Observation type: ⊗ Interferometry, ◯ Spectroscopy, ◯ Pulsar, ◯ Phase referencing

(14) Proposal is ⊗ Suitable for dynamic scheduling.

(15) Polarization: ⊗ Single Polarization ◯ Dual Circular Polarization
Global network standard for single polarization is LCP for all λs except 13cm (RCP) and 3.6cm (RCP).

(16) Tape usage (Show <recording time>/<total time>): _____

(17) Assistance required:
Observation Setup: ◯ Consultation, ◯ Extensive help, ◯ Observe file preparation
Postprocessing: ◯ Consultation, ◯ Extensive help, ◯ Calibration service

(18) Processor: ⊗ Socorro, ◯ JIVE, ◯ Haystack, ◯ Bonn, ◯ Washington, ◯ Other_____
Special processing: ◯ XPol, ◯ Pulsar gate, ◯ Multiple Fields: _____
Averaging time: 0.5 sec Spectral channels per baseband channel: 64
◯ Other special processing: _____

(19) Postprocessing Location: NRAO-CV, MPIfR, GSFC

(20) Source list: ◯ J2000 ◯ B1950
If more than 4 sources, please attach list. If more than 30, give only selection criteria and GST range(s)

	Source 1	Source 2	Source 3	Source 4
Name(s)	ALL SKY			
RA (hh mm)	0–24h			
Dec (dd.d)	–45d to +88d			
GST range (Europe)				
GST range (US)	0–24h			
GST range (Other)				
Band(s)	S/X			
Flux density (Total, Jy)	>50 mJy			
Flux density (correlated, mJy)	>50 mJy			
RMS needed (mJy/beam)	3–5 mJy			
Peak/RMS needed	>100:1			

(21) Preferred VLBI session or range of dates for scheduling, and why:
Two 24 hour session.

(22) Dates which are NOT acceptable, and why:

(23) Attach a self-contained scientific justification, not in excess of 1000 words.
Preprints or reprints will not be forwarded to the referees.

Information about the capabilities of the VLBA may be found on the World Wide Web by starting at the NRAO home page, http://www.nrao.edu, and selecting the VLBA from "Sites and Telescopes."

A brief summary of the capabilities of the EVN antennas is given in the EVN STATUS TABLE in the EVN USER GUIDE, which may be found at http://www.evlbi.org/user_guide/user_guide.html.

Please include the full postal addresses for first-time users or for those that have moved (if not contact author).

Follow-up of the VLBA Calibrator Survey

1 Summary

We request two 24 hour blocks of VLBA observing time as a follow-up of highly successful VLBA Calibrator Survey campaigns in order to evaluate 200 potential calibrator sources needed for successful phase referencing. ¿From the previous VLBA observations in 1994–2005 (proposals BB023, BF071, BP110, BP118, and BK125) the positions of 3205 sources, their maps and visibility data were derived. Together with the catalogue of compact radio sources obtained during 20 years of geodetic VLBI, a combined catalogue contains positions of 3489 sources. Among them, the position accuracies of 2899 sources is better than 25 nrad (5 mas). These sources are suitable as calibrators for phase referencing and as target sources for geodetic VLBI.

2 Previous Observations

VLBA Observing programs BB023, BF071, BP110, BP118 and BK125 were designed to expand the list of calibrator sources suitable for phase referencing, for geodetic observations, and for space navigation. The need for separations of no more than several degrees between the calibrator and target source for successful phase referencing, e.g., [1], requires a list of several thousand calibrator sources. Twenty two VLBA Calibrator observing sessions, each of 24 hours, were made between 1994 and 2005. Each source was observed 2–3 times at different hour angles for 1.5–4 minutes. In this way up to 200 sources could be observed in each 24 hour session with sufficient sensitivity and u-v coverage to determine their suitability as phase-reference calibrators. The position errors for 50% of the sources are less than 5 nrad (1 mas) and for 90% of the sources are less than 25 nrad (5 mas).

We observed simultaneously at S/X bands with the standard frequencies and spanned bandwidths used by most astrometric and geodetic campaigns. This allowed us to obtain ionosphere-free linear combinations of group delay observables used for determination of the milli-arcsecond accurate radio positions with the GSFC software package Calc/Solve.

The results from the above observations were published, [2], [4], [7], [8], [5] and made available on the Web at `http://www.vlba.nrao.edu/astro/calib/` and `http://vlbi.gsfc.nasa.gov/vcs/`. In the web sites, all sources within a specified distance from a selected target position can be found, and images and visibility plots for each potential calibrator can be scrutinized.

The scientific value of the images should not be underestimated. Most images have a dynamic range about or better than 100:1 and display many morphologies of AGN with milli-arcsecond resolution. Because of the large number of sources and their relatively unbiased selection, these data offer an archive for testing various models of AGN emission, motion and beaming, as well as finding unusual radio morphologies.

3 Proposed Observations

However, despite a significant increase in the pool of calibrators, complaints are not uncommon, that "there is no calibrator just in the area where our interesting target is located". Since nowadays more than 50% of VLBA and EVN observations are currently carried out with a phase calibrator, it is very important to provide even more calibrators. Although in the case when no calibrator near the interesting target is found, a proposer may select to request special observations of candidate sources around the target, to analyze the data himself and to derive positions of these sources, the existence of the list of high quality calibrators with very accurate positions eliminates this step and makes planning of observations much easier. We note that a recent proposal BP125 is now waiting for observations at 23 GHz in order to find over 500 calibrators near the galactic plane.

In order to address the need to increase the number of known calibrators, we request two additional 24 hour observing sessions with the VLBA. We propose a) to re-observe 50 compact sources with known problems and b) to observe 250 new candidate sources. The sources for re-observing had large apriori errors of more than $30''$ in the previous sessions. They were detected only on some short baselines and their positions had large uncertainty, 20–200 mas, so they were not recommended as calibrators. New observations with much better apriori positions should fix this problem. Some sources from the VLBA Calibrator list observed in 1994 at 64 Mbit/sec recording rate with 90 seconds integration time, which had insufficient amount of data to derive reliable positions, will be re-observed

with longer integration time. The new candidate sources will be taken from the JVAS catalogue [6], [3], [9] and from the VERA Fringe Search Survey campaigns (Petrov at el, in preparation, `http://vlbi.gsfc.nasa.gov/fss`) using the strategy used in the previous surveys. According to [8] that strategy yielded detection rate of 70–80%.

Observations should be done in two 24 hour run, as is usually done for absolute astrometry observations, in order to minimize systematic errors.

Although the main purpose of this experiment is community service, these observations will also address long-term scientific goals of proposers for creation of a homogeneous flux limited sample of compact sources. The sample will allow to investigating various statistics:

- to measure the brightness temperature for the core and jet components in order to populate a model of the distribution of the observed core brightness temperature in terms of the intrinsic properties of relativistic jets such as the brightness temperature, bulk motion, viewing angle. The data will also provide the unbiased sample needed to investigate the unified scheme between quasars, BL Lacs and galaxies.
- to test the dependence between the angular size of the core-jet region and the redshift. This dependence can be interpreted as a measure of the cosmological term q_o.
- to analyze the relationship between the core optical depth as measured by the spectral index and other properties of the jet emission and optical properties.
- to investigate the variation of the spectral index along the presumably optically thin jets and comparison with the conditions in small-scale and larger-scale jets.

New sources will have expected correlated flux densities at a level of 100–200 mJy, since brighter sources have already been observed. The new sources are supposed to improve completeness of the sample for sources with lower flux densities.

We propose to observe in the same manner as previously, dual S/X band with wide spanned bandwidth, two scans per source and 10 minute bursts of troposphere calibrators over the sky every 1.5–2 hours. Eight IF channels, four near 2.3 GHz and four between 8.1 to 8.5 GHz are proposed, with a total bandwidth of 64 MHz at 1 bit sampling, 128 Mbit/s. For the correlator setup we request 64 spectral channels in each IF and integration time 0.5 sec. This will give us an extra-wide search window needed for fringing sources with poorly known a priori positions. The calibration and imaging will be made by using packages AIPS and difmap. Positions will be determined with Calc/Solve. Both positions and maps in fits format will be included in the VLBA Calibrator list and become available to the community on the Web within 30 days upon completion of correlation.

References

[1] Beasley, A. J., in *Very Long Baseline Interferometry and the VLBA*, 1995 ASPCS, 82, 327

[2] Beasley, A. J., Gordon, D., Peck, A. B., Petrov, L., MacMillan, D. S., Fomalont, E. B., & Ma, C. 2002, ApJS, 141, 13

[3] Browne I. W. A., Patnaik A. R., Wilkinson P. N., Wrobel J. M. MNRAS, 293, 257, 1998.

[4] Fomalont, E. B., Petrov, L., MacMillan, D. S., Gordon, D., & Ma, C., 2003, AJ, 126 (N5), 2562, 2003.

[5] Kovalev, Y. Y., Petrov, L, Fomalont E., Gordon D., in preparation, 2006.
`http://vlbi.gsfc.nasa.gov/vcs5`

[6] Patnaik A. R., Browne I. W. A., Wilkinson P. N., Wrobel J. M. MNRAS, 254, 655, 1992.

[7] Petrov, L, Kovalev, Y. Y., Fomalont E., Gordon D., AJ, 129, 1163, 2005.
`http://arxiv.org/abs/astro-ph/0409698`

[8] Petrov, L, Kovalev, Y. Y., Fomalont E., Gordon D., AJ, 131, 1872, 2006.
`http://arxiv.org/abs/astro-ph/0508506`

[9] Wilkinson P. N., Browne I. W. A., Patnaik A. R., Wrobel J. M., Sorathia B., MNRAS, 300, 790, 1999.